International Journal of Advanced Trends in Computer Applications
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Adaptive priority based shortest path routing for the WDM optical Networks

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Abstract: *Routing and wavelength assignment has become a critical in all optical networks as on the basis of it the network performance is estimated. We can work upon the various network parameters like blocking probability, throughput, and error rate by choosing the optimal routing and wavelength assignment methods. In this proposed work we are proposing the dynamic adaptive shortest path routing algorithm which chooses the best possible light path between the source &destination pair. Furthermore routing algorithm and wavelength assignment technique can be used to evaluate the blocking probability, error rate, throughput and the routing overhead of EONNET, INTERNET2NET, NFSNET and SIMPLENET4 network topologies.*

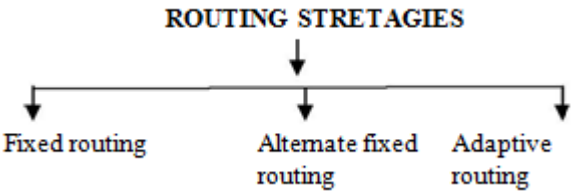
Keywords: WDM, Optical Network, Blocking Probability, Throughput, Bit error rate, Traffic Grooming, Routing and Wavelength Assignment (RWA).

1. Introduction

The explosive growth of the internet over the past few years has increased the demands for the high bandwidth requirements with the need of less noise interference and signal distortions. The solution comes in the form of WDM optical networks. WDM is based on the well-known concept known as the FDM (frequency division multiplexing) [1]. With this technology the part of bandwidth channel is divided in the number of channels and each channel occupies the part of frequency spectrum. WDM transmission technology is nowadays widely used in optical network communication. Here 'wavelength' used is actually the channel of the WDM networks. WDM technology was employed to take the full advantage of the optical fiber. In WDM one strand of the optical fiber can accommodate upto 128 channels. WDM networks are able to integrate the data and voice in the single telecommunication networks because of its transparency over the data rate and data formats.

Along with the technology of WDM there comes the need of the routing and wavelength assignment i.e. RWA problem. In routing problem data is routed from the source to destination pair by forming the light path and then assigning the particular wavelength to the path [2]. The wavelength assignment strategies are of various types. Depending upon the application and the requirements the various strategies of the wavelength assignment can be employed. Thus for the establishment of the particular connection one has to take care of the selection of the path and then assigning of the particular wavelength to that path. This problem is known as the routing and wavelength assignment problem (RWA). But there exists the two main constraints one is wavelength continuity constraint and other is distinct channel constraint. The solution to the RWA problem comes in two ways either considers this problem as the single one or either divide the problem in two sub problems i.e. routing and the wavelength assignment [3].

The various types of routing strategies are elaborated in the figure below.



Various routing algorithms were proposed in the literature but few of them are been discussed below:

Fixed routing: In this routing technique the path between source and destination pair is calculated off-line using various algorithms [4].

Fixed alternate routing: In this the alternate paths are selected off-line between pair of nodes instead of selecting a single path as in case of fixed routing. This algorithm is mainly used in case of link failures and recovery [5].

Adaptive routing: This routing strategy is mainly used in the case of dynamic networks and it routes the data stream online according to the network state [6].

In literature most of work is done with static routing and a very few work is done with dynamic routing. The previous work was done with the dynamic routing by considering the multiclass traffic i.e. the various classes are formed in the network communication which depends upon the network traffic, bandwidth availability and the other resources for the communication. In dynamic routing, routing protocol which is operating on the router is responsible for the maintenance, creation and updation of the dynamic routing table. All the routing process is carried out on-line [7].

In all wavelength routed networks blocking probability is an important parameter which is needed to be considered for a light path request. Blocking parameter depends upon the many factors like network topology, traffic load, RWA technique used and wavelength converters availability [8]. Network with wavelength conversion has little call blocking i.e. less blocking probability. With the increase in the load on the fixed nodes in the network the blocking probability also increases and it also depends upon the wavelength assignment technique used for example for the network of 10 nodes the results shows that the performance of first fit wavelength assignment is better than the random fit wavelength assignment [9].

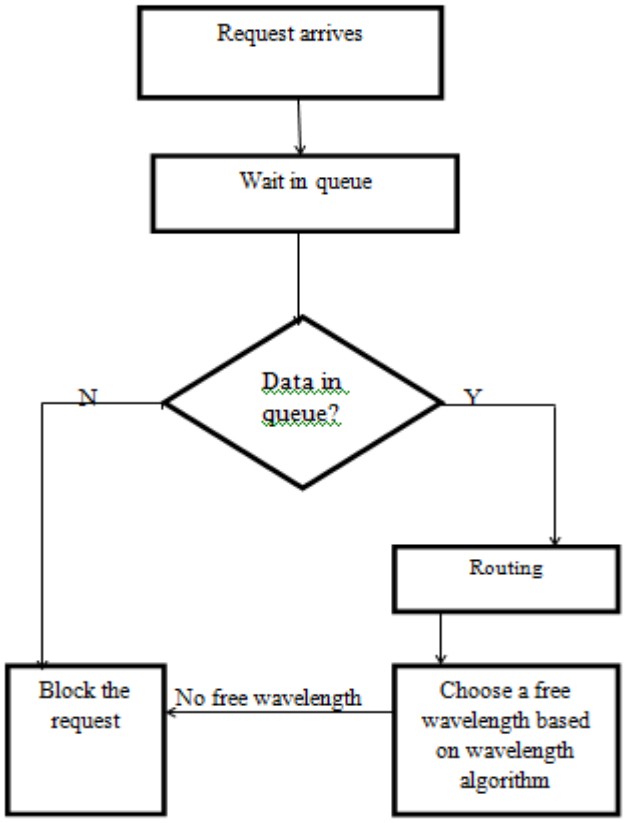


Fig 1: Architectural diagram for the wavelength assignment algorithm

In the optical WDM networks, finding the route and then assigning the wavelength to that particular light path is an important part of communication system. The figure above depicts the assignment of the wavelength assignment for the connection request [10].

2. PROPOSED RESEARCH WORK

This work studies routing strategies on wavelength division multiplexed (WDM) all-optical networks. The objective is to minimize the overall routing light path by choosing the dynamic path routing which is discussed below in the flow chart. To achieve high bandwidth utilization, guarantee low delay, and ensure short-term fairness, we try to construct a schedule with shortest light path finding solution. The WDM (wave length division multiplexing) offers large network capacity, so high speed data transfer is possible. The optical paths guarantee network availability for job-execution assurances, so data transfer is reliable, motivated to achieve a smaller latest job completion time.

The algorithm helps to optimize the various network parameters like Blocking probability, Bit error rate, Throughput and the Routing overhead. The algorithm works on the assumption that if the source and destination exists in the distance range of 200 to 250m than the data is send directly otherwise the Coverage set of the network is formed and the shortest path is searched using the distances in the coverage set. In this research we will be working on the four types of network topologies with the varying network traffics

according the no. of nodes selected for the network. The four networks are EONNET, INTERNET2NET, NSFNET, and SIMPLENET4.

ALGORITHM OF PROPOSED STRETAGY

Start

Configure Network = N
Initialize source to send information to destination = S

Initialize Coverage set from detected source node = CS

Where coverage set is at the distance supposing it is 200 ≈250 m then sent directly from Source to Destination

If source S = Destination D = Coverage Set CS then it is called Shortest Path.

Do
Data transfer directly.
Else
Find nearest neighbor to that node.

Do
For right side
{
If present node is on right side of the coverage set
}
Node is positively detected
For left
{
If present on left side of the coverage set
}
Node is positively detected.

If node is negatively detected in the coverage set
Do
{
Find positively detection of node
}
Then
Find minimum distance from the detected nodes to find neighbor nodes
Do while
{
Again find in the coverage set
}
Else
{
Selected node is another one
}
Continue till destination = TRUE
If nodes= 8
Do
Node no. 8 = data transfer directly.

For iteration=length of the sorted route
{
Evaluate Blocking probability of the proposed scheme and calculate error rate and routing overhead
}
Stop

METHODOLOGY

The simulation is done with the help of MATLAB The simulation setup is made of various nodes transmitting packets on WDM unidirectional optical network. To find out the blocking probability and other metrics, we need to find out the coverage set, so that shortest path can be found out. There are two cases, if source and destination are in the coverage set of the node then it is shortest path. In second case, if the second node is not in the coverage set of the current node than find out the nearest neighbor so that shortest path can be determined. Further it has also two cases, if node is positively detected then neighbor is on left side but if it is negatively determined then it is on right side. Then on the basis of it data transfer takes place.

ARCHITECTURE OF PROPOSED APPROACH

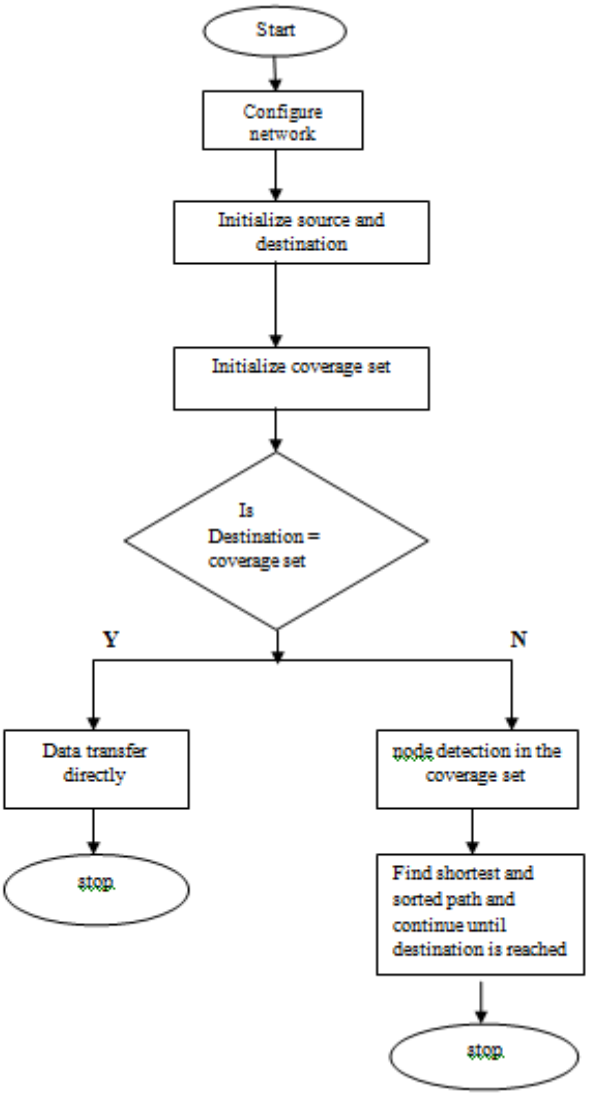


Fig. 1 Flow chart showing the steps involved in data transmission

3. RESULTS AND DISCUSSION

We designed and developed a simulator to implement scheduling and wavelength assignment in optical networks. The simulator is developed in MATLAB tool. It accepts input parameters such as the number of nodes in the network, link information with weight, distance, blocking probability, throughput, bit error rate. Some of the calls may be blocked because of the unavailability of free wavelength on links along the route from the source to the destination. The ratio of the total number of calls blocked to the total number of light path requests in the network is defined as the blocking probability.

The output of the simulator is the blocking probability for the specified parameters along with the detailed information of connections. Network throughput is the rate of successful message delivery over a communication channel. The data these messages belong to may be delivered over a physical or logical link, or it can pass through a certain network node. Throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. The bit error rate or bit error ratio (BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval. BER is a unit less performance measure, often expressed as a percentage.

All these parameters can be initializing before running the simulations to obtain results for a given selection of parameters.

The tables and graphs below are generated for the NFSNET of 20 nodes and the corresponding route is generated as the shortest path from the source to the destination such that the blocking probability is reduced and throughput is increased with the reduced bit error rate.

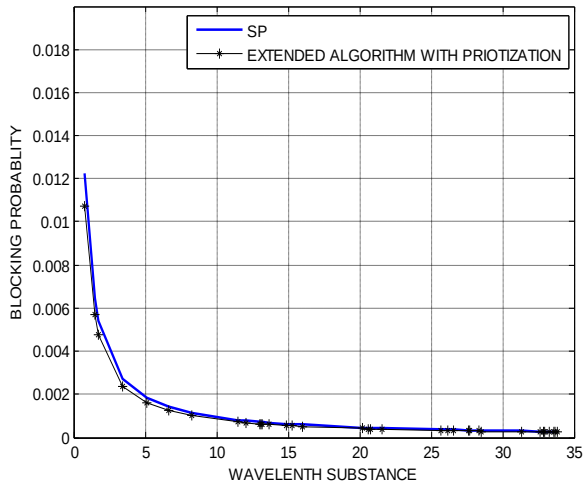


Figure 1: Blocking Probability

Node no.	SP Algo	Extended
2	0.012	0.010
10	0.001	0.0009
15	0.0009	0.0008
18	0.0007	0.0006
30	0.0005	0.0004
35	0.0004	0.0001

Table 1: Blocking probability

Above showed are the graph and their corresponding values are showed in the table of blocking probability. The graphs clearly show that the previous algorithm was offering more blocking probability as compared to the proposed algorithm.

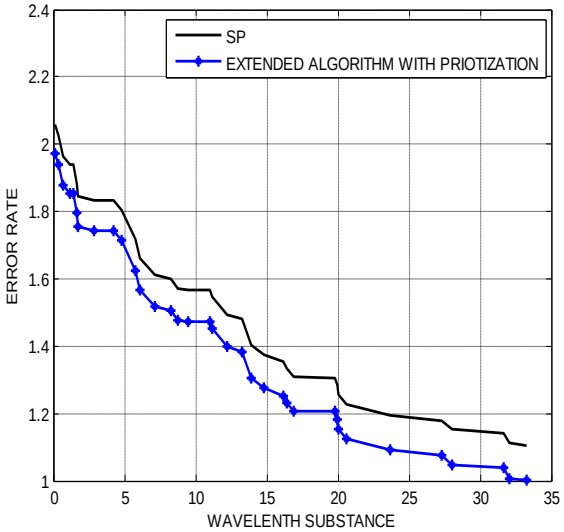


Figure 2: Bit error rate

Node no.	SP Algo	Extended
2	2.23	1.85
10	1.45	1.55
15	1.39	1.25
18	1.35	1.22
30	1.19	1.17
33	1.16	1

Table 2: Bit Error rate

Above table shows the table of bite error rate. It is the performance parameter which should be less in the system to get the appropriate output of the network.

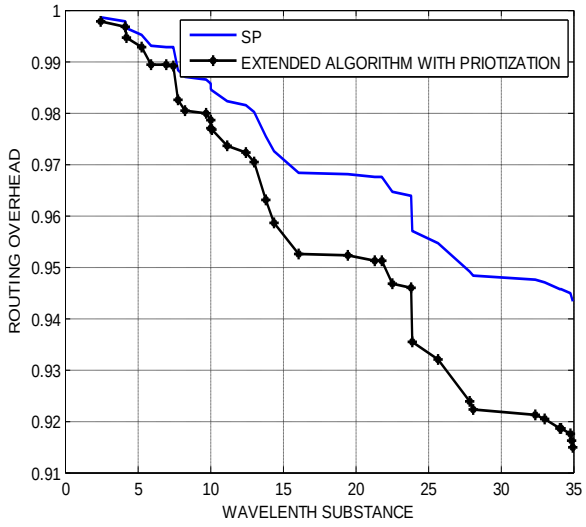


Figure 3: Routing Overhead

Node no.	SP Algo	Extended
2	0.999	0.993
10	0.986	0.975
15	0.97	0.955
18	0.969	0.956
30	0.949	0.92
33	0.947	0.912

Table 3: Routing overhead

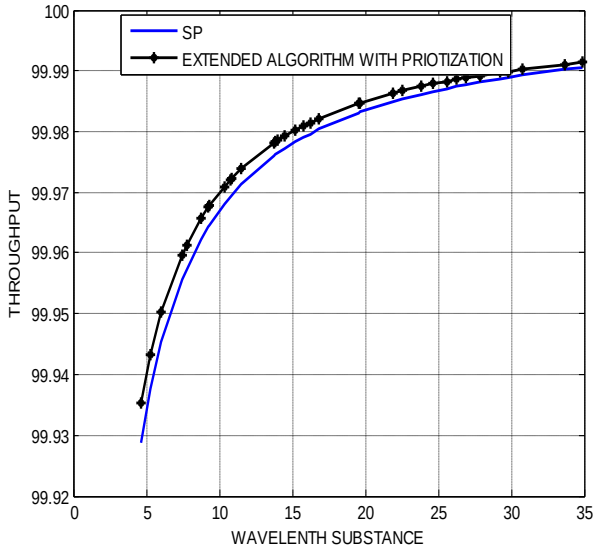


Figure 4: Throughput

Node no.	SP Algo	Extended
4	**99.92**	99.931
10	99.95	99.97
15	99.975	99.98
20	99.982	99.985
30	99.98	99.984
35	99.991	99.995

Table 4: Throughput performance

Above mentioned graphs and their tables shows various network parameters are optimized as compared to the approach used in the previous work. Bit error rate is the ratio of the no. of erroneous bits sent over the network the total number of bits sent. Its value is also reduced using the proposed strategy. Throughput of proposed algorithm is improved in comparison to Shortest path method, because in previous approach data transfer was taking place directly, it did not considered whether in the routed path blocking of the data packets was occurring or not.

4. CONCLUSION

The blocking performance of the WDM network is analyzed for a network having various nodes and for varying available wavelength. So this paper presents a simulating technique for examining the blocking probability, throughput and bit error rate of algorithms for different wavelength assignment in optical ring network. First we obtained the blocking probability with the variation number of available free wavelength. After that we compared the simulation results obtained for calculating the blocking probability for each of this algorithm. It was analyzed that the Most algorithm offers more blocking probability and the proposed algorithm offers the least blocking probability. This model suggests us to choose the best path with the specified load and appropriate number of wavelengths to be allocated in the network.

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